6.4 Mechanical, Electrical, and Plumbing Components

6.4.1 Mechanical Equipment

6.4.1.6 Suspended Equipment

This category covers any type of suspended equipment items other than HVAC equipment suspended in-line with ductwork, such as unit gas heaters.

Provisions

BUILDING CODE PROVISIONS

Seismic loads for suspended equipment are determined using ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010), Chapter 13. The principal objective is to prevent the component from falling.

- ASCE/SEI 7-10 requires anchorage for all suspended equipment in Seismic Design Categories D, E, and F weighing over 20 pounds. Lighter items may be exempt if the component Importance Factor $I_p = 1.0$.
- Unbraced piping attached to in-line equipment must be provided with flexibility adequate to accommodate seismic relative displacements.
- Items that are exempt from the anchorage requirements noted above are still required to be positively anchored to the structure. The anchorage need not be designed or detailed on the construction documents. Flexible connections must be provided between the equipment and associated pipes, ducts, or conduits.

RETROFIT STANDARD PROVISIONS

For suspended equipment, ASCE 41-06, *Seismic Rehabilitation of Existing Buildings* (ASCE, 2007) requires compliance with the anchorage provisions of the standard when the performance level is Immediate Occupancy, or the performance level is Life Safety and the component is gas-fired and located in areas of high seismicity. These components are classified as force controlled.

- Anchorage should be provided if the item weighs over 20 pounds and is mounted over 4 feet above the floor.

Typical Causes of Damage

- Poorly supported suspended items may lose support and fall.

- Suspended items can swing and impact building elements or other equipment.
- Internal components may be damaged by shaking or impact.
- Connections of fuel lines or other connected piping may be damaged.
- Equipment may cease to function due to misalignment or internal damage.

DAMAGE EXAMPLES

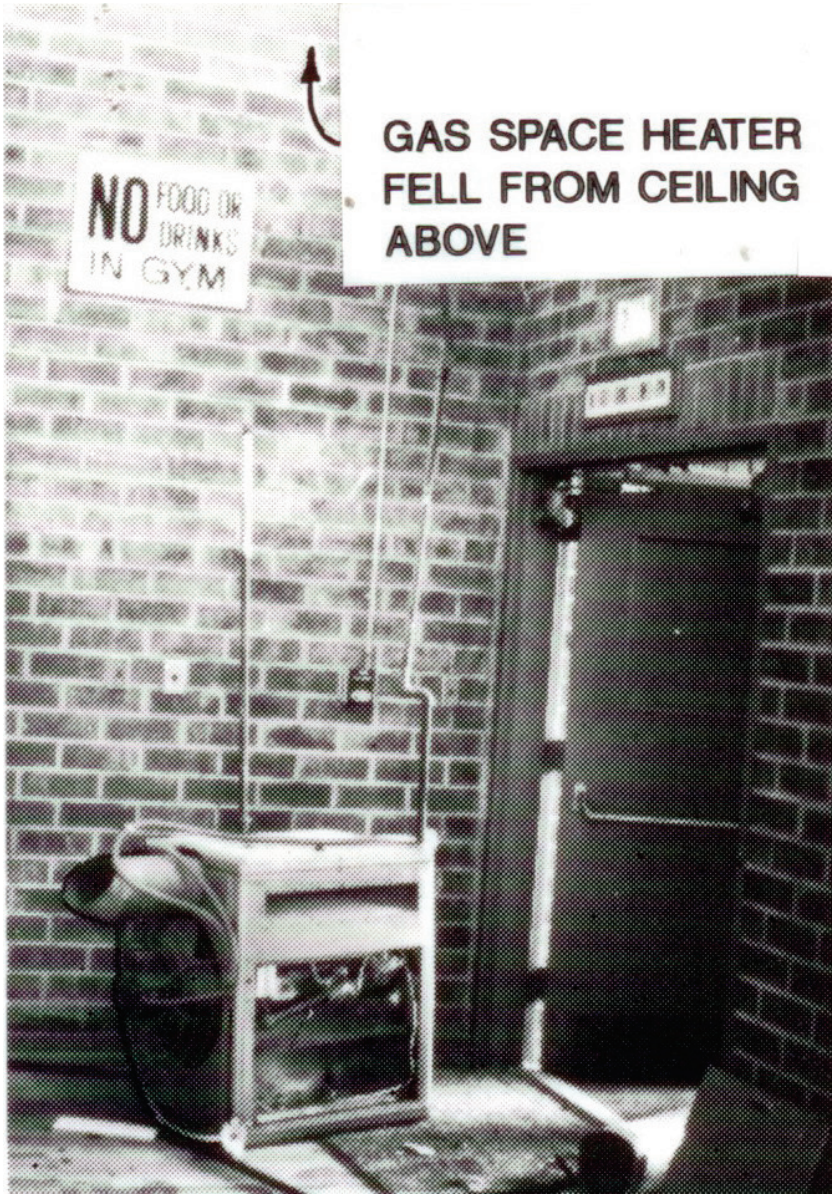

Figure 6.4.1.6-1 Gas space heater fell from ceiling above in the 1971 magnitude-6.6 San Fernando Earthquake (Photo courtesy of C. Wilton, Scientific Service, Inc.).

Seismic Mitigation Considerations

- Detail shown provides rigid attachment for small suspended equipment weighing less than 150 pounds. Two or more double angle assemblies could be used for larger items. If the equipment is suspended with rigid, unbraced hangers, the details shown may be adapted to provide diagonal bracing.
- Provide flexible connections for fuel lines.
- Refer to Section 6.4.1.5 for details for suspended HVAC items; these details can be adapted for multiple suspended items. See also FEMA 412 *Installing Seismic Restraints for Mechanical Equipment* (2002) and FEMA 414 *Installing Seismic Restraints for Duct and Pipe* (2004) for additional information and details.
- Several engineered seismic bracing systems are available for suspended equipment and can be customized for most applications, more options may be found on the internet.

MITIGATION DETAILS

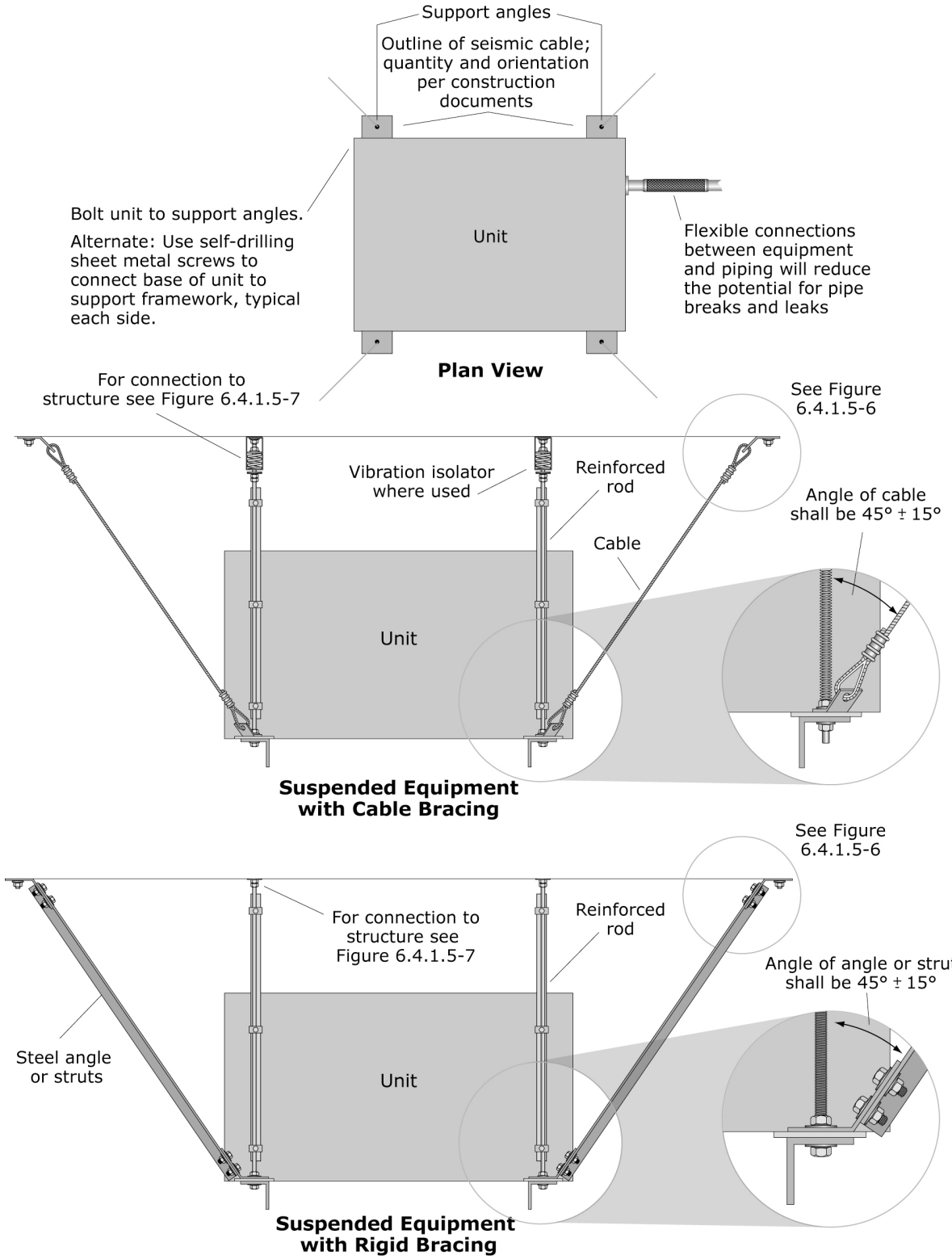

Figure 6.4.1.6-2 Suspended equipment (ER).